

Arizona Department of Water Resources
WQARF Support Unit – Hydrology Division

Special Well Construction and Abandonment Procedures

Pinal Creek WQARF Site
Finalized August 27, 1998



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SPECIAL WELL CONSTRUCTION AND ABANDONMENT PROCEDURES FOR

PINAL CREEK WQARF SITE

INTRODUCTION

The design, procedures, and materials used during the drilling or abandonment of a well must prevent vertical cross-contamination between an aquifer or aquifer layer and ensure the seal integrity. The following are conditions to be met in addition to the Arizona Department of Water Resources (ADWR) *Statutes and Rules Governing Minimum Well Construction Standards* (August 22, 1997) (R12-15-801 through R12-15-822). Section R12-15-812(B) specifically applies towards these procedures since this area contains mineralized or polluted water. The area for which special well-construction and abandonment procedures apply is shown in Figure 1. These conditions apply to all well types within the defined area.

As noted by the Pinal Creek Group (PCG), special well construction and abandonment procedures are needed within the Pinal Creek Water Quality Assurance Revolving Fund (WQARF) site to protect portions of the Gila Conglomerate which are not currently impacted from the contaminated ground water in the alluvial aquifer or upper contaminated portions of the Gila Conglomerate. As stated by PCG, “wells that penetrate the alluvial aquifer have the potential to encounter acidic groundwater, whereas groundwater in wells in the Gila Conglomerate is unlikely to be acidic” and “wells in shallow Gila Conglomerate close to the alluvial aquifer are most likely to be exposed to neutralized groundwater with elevated concentrations of T.D.S.”. The Gila Conglomerate is the main source of drinking water in the area.

To clarify applications of the well-construction procedures to site-specific conditions, four types of well/aquifer occurrences are identified: 1) wells installed through the contaminated alluvial aquifer, 2) wells installed only in Gila Conglomerate where the upper portions of the Gila are contaminated, 3) wells installed only in Gila Conglomerate where the upper portions of the Gila are not contaminated, and 4) wells installed through mine tailings or other mine waste. To expedite the review process, a well-construction diagram shall be submitted by the applicant to ADWR at the time the application is submitted.

WELL INSTALLATION PROCEDURES

Wells Installed Through the Contaminated Alluvial Aquifer

All wells drilled through or adjacent to the contaminated alluvial aquifer shall be generally constructed as shown in Figure 2. Adjacent will be defined as within 100 feet of the boundaries of the alluvial aquifer or within a zone of influence from the contaminated aquifer. The total depth, borehole diameter, and casing diameter will vary; however, the relationships between well-construction specifics shall remain constant. Vertical cross-contamination will be prevented by the installation of an outer conductor casing to a minimum depth of 25 feet into the Gila Conglomerate or any other water-producing strata. With the exception of monitor wells and piezometers, wells impacted by contamination from the alluvial aquifer shall not be installed with screened intervals open to such ground water.

High-solids bentonite grout shall be used to pressure grout the outer conductor casing in place and fill the annular space to 10 feet above the highest known water level of the alluvium, at which point an acid resistant cement (pozzolanic cement) should be used between the outer conductor casing and the borehole. Refer to Table 1 “Annular Seal Materials and Mixtures” for the proper mixing ratios. The thickness between the borehole and the outer conductor casing shall be a minimum of 2 inches to ensure sufficient room to emplace annular seals as recommended by U.S.E.P.A., March 1991, p. 86 and Driscoll 1986, p. 443.

In all cases, the well shall be designed so that the top of the screened interval is a sufficient distance below the contact between the alluvial aquifer and the Gila Conglomerate or any other water-producing strata. Sufficient distance is defined as no less than 120 feet unless a demonstration can be made that would warrant a variance from this requirement. The minimum depth is based upon PCG’s recommendation and ADWR believes the minimum depth to be appropriate as it will prevent production of potentially contaminated ground water and lessen any vertical leakage across hydrogeologic contacts due to a reduction in head. Monitor wells and piezometers will not apply to this condition.

As stated within the *Statutes and Rules Governing Minimum Well Construction*, all joints shall be waterproof to prevent leakage of fluids. Threaded flush joints are preferred within areas of known ground water contamination (EPA, March 1991, p. 85). The casing material must be chemically inert with contaminants of concern within the ground water as recommended by EPA, March 1991, p.75.

At least three to five feet of fine silica sand (less than approximately 0.25 millimeter diameter) shall be placed over the filter pack material to form a barrier to the slurry of high-solids bentonite grout which is used to fill the annular space. High-solids bentonite grout shall be used to fill the annular space from the top of the fine silica sand interval to 10 feet above the highest known water level of the alluvium, at which point an acid-resistant cement (pozzolanic cement) should be used to complete the grouting of the annular space to the land surface.

Wells Installed Only in Gila Conglomerate Where the Upper Portions of the Gila are Contaminated

The construction for wells drilled only in the Gila Conglomerate where the upper portions of the aquifer are contaminated shall follow the well construction standards of the wells penetrating the alluvial aquifer in all detail except that the installation of the outer casing is optional. If the well is drilled between zones of ground water which differ significantly in water quality, the drilling procedure must minimize the migration of contaminated water from each ground water zone to lessen vertical cross-contamination during drilling **as required by ADWR *Statutes and Rules Governing Minimum Well Construction Standards*** (August 22, 1997) Section R12-15-812(B). Figure 3 shows a schematic for wells to be drilled under these conditions.

Wells Installed Only in Gila Conglomerate Where the Upper Portions of the Gila are not Contaminated

The well construction shall be the same as for installing a well through upper portions of the Gila Conglomerate that are contaminated. Special consideration should be given for wells installed only in Gila Conglomerate to place the top of the screen deep enough to minimize the potential for drawing in high Total Dissolved Solids (TDS) water.

Wells Installed Through Mine Tailings or Other Mine Waste

The well construction shall follow the requirements of wells drilled through the alluvial aquifer in all detail. If the well drilled does not penetrate any other ground water zone(s), the outer casing can be optional. The drilling procedure must minimize the migration of contaminated water from each ground water zone to lessen vertical cross-contamination during drilling as recommended by EPA 1991, pg. 40-43, 147-149.

WELL ABANDONMENT PROCEDURES

Abandonment Procedures For Wells in the Alluvial Aquifer Only

Wells drilled within the alluvial aquifer only shall be abandoned in conformance with the requirements of Arizona Administrative Code (A.A.C.) R12-15-816. In addition, the well shall be filled completely with a high-solids bentonite grout from the bottom of the well to 10 feet above the highest known water level within the well, at which point an acid-resistant cement (pozzolanic cement) shall be used to complete the abandonment. The depth of the alluvium/Gila contact must be demonstrated to ADWR prior to abandonment through well logs and/or video or geophysical methods. The demonstration shall be relative to well design and submitted during the application process.

Abandonment Procedures For All Other Wells Within the Application Area

The casing shall be pulled if and only if it is known that this can be accomplished. If the casing is not pulled, either the well shall be overdrilled or the casing shall be perforated over its entire length with a minimum of 2 cuts per foot and pressure-grouted. The well shall be filled completely with a high-solids bentonite grout from the bottom of the well to 10 feet above the highest known water level of the well, at which point an acid-resistant cement (pozzolanic cement) shall be used to complete the abandonment to the land surface.

The estimated volume of grout material shall be submitted to ADWR 5 days prior to abandonment and the actual amount of materials used shall be reported to ADWR within 10 days after abandonment.

REFERENCES

American Society for Testing and Materials (ASTM), 1992. Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities, D5299-92. ASTM, West Conshohocken, PA, pp. 167.

Arizona Department of Water Resources, 1993. Statutes and Rules Governing Minimum Well Construction Standards and the Licensing of Well Drillers.

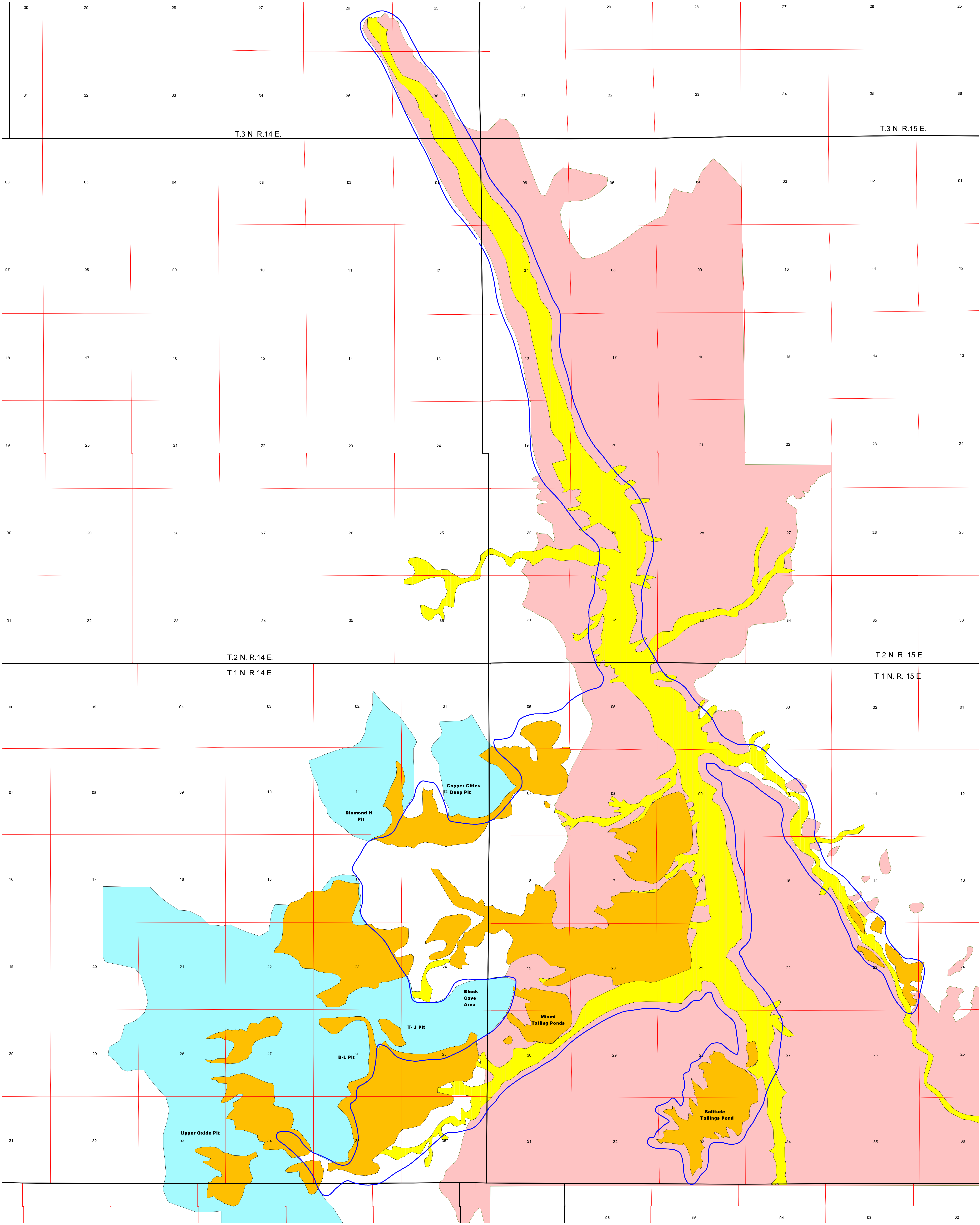
Driscoll, F.G., 1986. Groundwater and Wells. Johnson Filtration Systems Inc., St. Paul, Minnesota.

U.S.E.P.A., March 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. Office of Research and Development. EPAJ600/4-89/034, pp. 40-86.

Table 1. Annular Seal Materials and Mixtures

Category	Specific Material	Mixing Ratio		Special Considerations
		Solids	Water	
Cement	Acid Resistant Cement (Pozzolanic Cement)	One sack of cement (94 lb.) and seventy-four (74) lbs pozzolans (fly-ash,perlites,etc.) 2 to 6% of bentonite by weight is needed if perlites are used	Not more than ten (10) gallons of water per sack of cement	Typically used in areas where low pH groundwater is encountered. If perlites are used, bentonite is needed to keep perlites from floating. Chemical admixtures and plastizers may be used to reduce viscosity. This mixing ratio is in accordance with ASTM D5299.
Bentonite	High-Solids Bentonite Grout (dry powder)	Fifteen (15) lbs. dry bentonite powder	Seven (7) gallons	Materials or mixtures must be emplaced under sufficient pressure to fill all voids, including all annular space(s), and displace water from the well. A tremie pipe must be used to emplace the grout from the bottom up. The end of the tremie pipe must remain in close proximity to the rising grout surface, as the grout is pumped into the well.

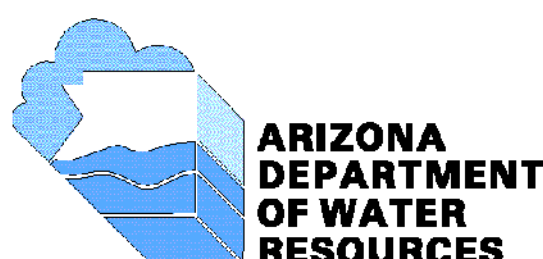
PINAL CREEK WQARF SITE
AREA FOR SPECIAL WELL CONSTRUCTION &
ABANDONMENT REQUIREMENTS - FIGURE 1.



- Special Requirements Area
- Township
- Section
- Mine Waste Pile
- Capture Zone of Hydrologic Sink
- Alluvium
- Gila Conglomerate

0.5 0 0.5 1 1.5 Miles

1:24000



Drafted by ADEQ July 1998
Revised by ADWR August 1998

The extent of the Gila Conglomerate has been modified from ADEQ's draft to fit within the subject area. The accuracy of the locations and topographic information has not been verified.

December, 2001

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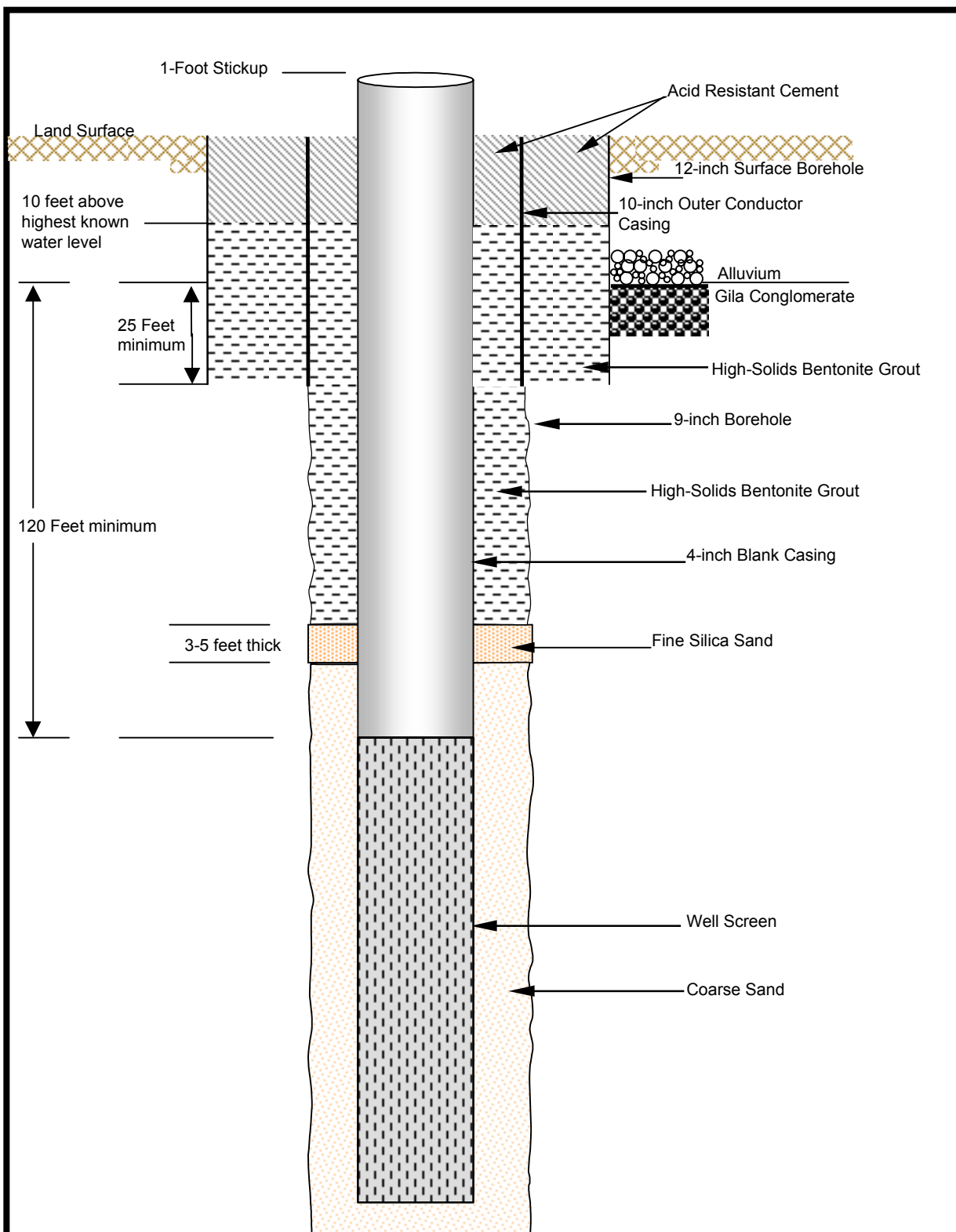


Figure 2.
Typical Schematic for
Wells Installed through the
Contaminated Alluvial Aquifer

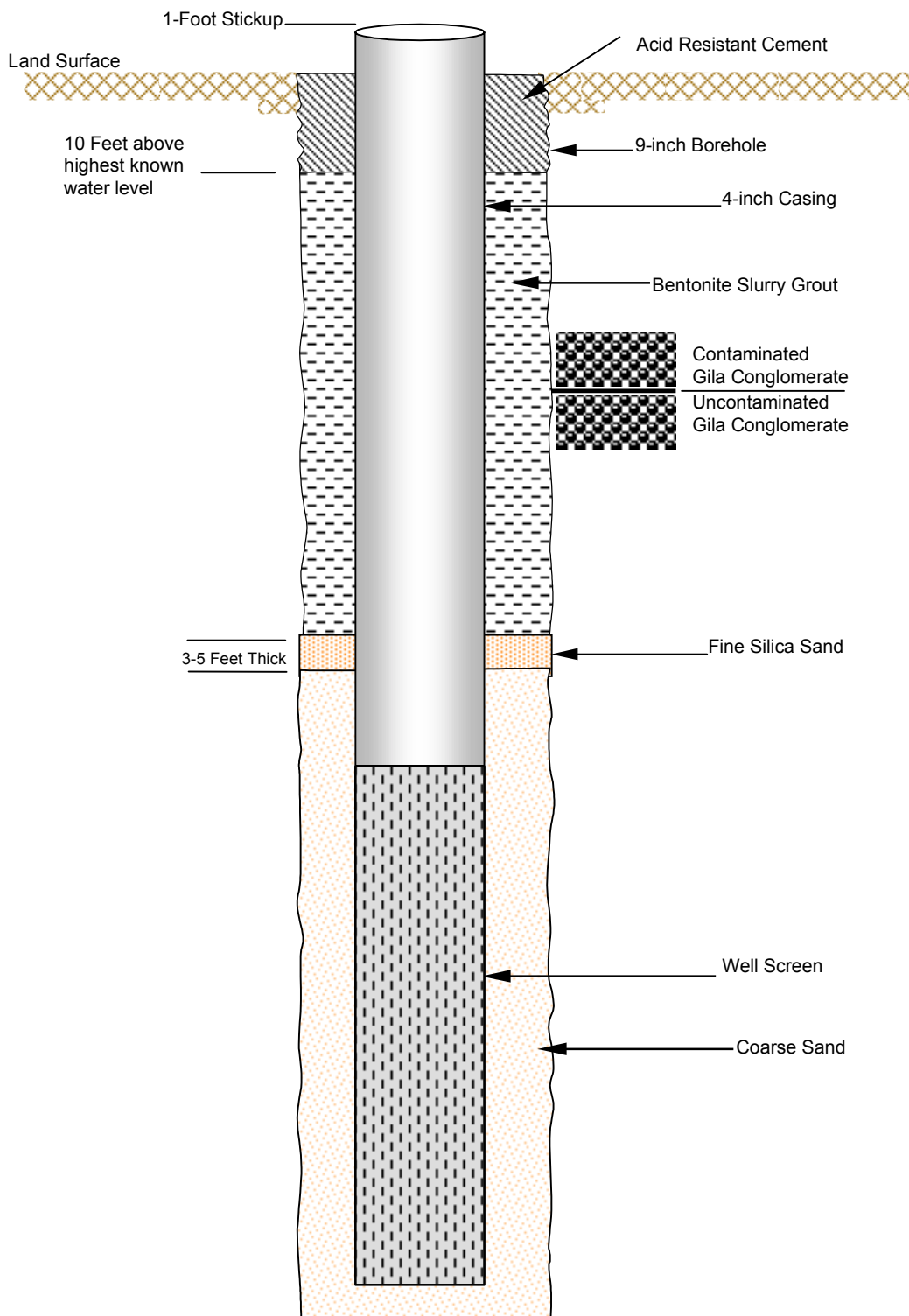


Figure 3.
Typical Schematic for Wells Drilled
Only in Gila Conglomerate